BIOFUMIGATION AS AN ALTERNATIVE TO METHYL BROMIDE FOR CONTROL OF WHITE GRUB LARVAE

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Masked chaffer beetle larvae (*Cyclocephala* sp.) are a common soilborne pest of several plants and are a representative species of white grub larvae. The larvae can be controlled by soil fumigation using methyl bromide. However, in accordance with the U.S. Clean Air Act, methyl bromide use will be banned by 2005.

One alternative control is to use the pesticidal compounds released by macerated *Brassica* tissues. *B. napus* has been used to decrease populations of Black vine weevil larvae (Borek et al., 1997) and Wireworms (Elberson et al., 1996). The pesticidal properties of *Brassica* spp. are derived primarily from the high concentration of glucosinolates that break down into isothiocyanates.

The objective of this study was to determine the lethal concentration of allyl isothiocyanate (AITC) released from Indian mustard (*Brassica juncea* PI 458934) for Masked chaffer beetle larvae.

Materials and Methods

Proportional amounts of *B. juncea* root, stem and leaf tissue were combined at the ratio of 1: 4.92: 6.13, respectively and macerated for 30 seconds. The *B. juncea* tissue was then mixed (at 1, 2, 4 and 8% of soil mass) with 335g of clay loam soil and 2.5g of Bermuda grass (*Cynodon dactylon*) root tissue (as a larval food source) and placed in sealed 473mL glass jars. Other treatments included tomato (*Lycopersicon esculentum*) tissue at 8% of soil mass; 1.2, 2.4 and 7.3µL AITC; untreated soil; and a 20% CO_2 soil atmosphere. Masked chaffer beetle larvae (*Cyclocephala* sp.) were collected from under Bermuda grass. Five larvae were placed in each treatment jar.

A Teflon tube was drilled with 32 holes and capped with a septum. This tube was inserted through the lid and into the soil to allow for collection of volatiles. A solid-phase microextraction device (SPME) was used for sampling and AITC was quantified by gas chromatography at 0.25, 4, 8, 24 and 48 h.

Jars were kept in darkness at 20EC and 40% humidity. After 48 h, jars were allowed to equilibrate to atmospheric conditions. Mortality counts were taken after 7 days. A general linear model (GLM) statistical analysis was used to determine the relationship between AITC concentration and mortality (SAS, 1989).

Results

AITC concentration at 4 h was positively correlated to larvae mortality (P#0.001). Larvae mortality was 0% for the untreated soil, soil amended with 8% tomato tissue, and the high CO_2 soil atmosphere (Table 1).

AITC standards killed Masked chaffer beetle larvae at a rate consistent with AITC concentrations produced by *B. juncea*. The atmospheric AITC concentration (4 h) for 50% (LC_{50}) and 90% (LC_{90}) mortality was estimated to be 4.2 µg•L^{-1} and 8.6 µg•L^{-1}, respectively (Fig. 1). The amount of *B. juncea* tissue required to produce this amount of AITC is between 4 and 8% of soil mass (Table 1; Fig. 1).

Conclusions

Biofumigation with high concentrations of *B. juncea* can control Masked chaffer beetle larvae, and demonstrates the potential for *Brassica* biofumigation as an alternative soil fumigant to methyl bromide. If *Brassica* species can be selected or developed with higher concentrations of isothiocyanates, including AITC, the effectiveness of *Brassica* biofumigation could be increased. The Masked chaffer beetle is typical of other similar pest species of white grub including the Japanese beetle, European chaffer beetle, Oriental beetle, and Asiatic garden beetle, which might also be managed with biofumigation.

Table 1: Mortality and AITC concentrations over time.

	%	AITC (µg L^{-1})[y]				
Treatment	**Mortality**	**0.25 h**	**4 h**	**8 h**	**24 h**	**48 h**
Control - Untreated	0.00	0.00	0.00	0.00	0.00	0.00
Control - CO_2	0.00	0.00	0.00	0.00	0.00	0.00
Control - 8% Tomato	0.00	0.00	0.00	0.00	0.00	0.00
Control - AITC 1.2 µg L^{-1} [z]	40.00	1.43	2.60	.	0.00	.
Control - AITC 2.4 µg L^{-1} [z]	100.00	1.84	9.18	.	0.88	.
Control - AITC 7.3 µg L^{-1} [z]	100.00	2.07	24.79	.	8.11	.
Brassica 1%	6.67	4.48	1.31	0.54	0.00	0.00
Brassica 2%	33.33	7.58	3.80	1.32	0.68	0.50
Brassica 4%	46.67	14.38	6.09	2.08	1.13	0.77
Brassica 8%	100.00	19.91	10.39	4.42	2.16	1.40

[z] Based on previous results, sampling at 8 h and 48 h was omitted.
[y] Numbers are means of three replications.

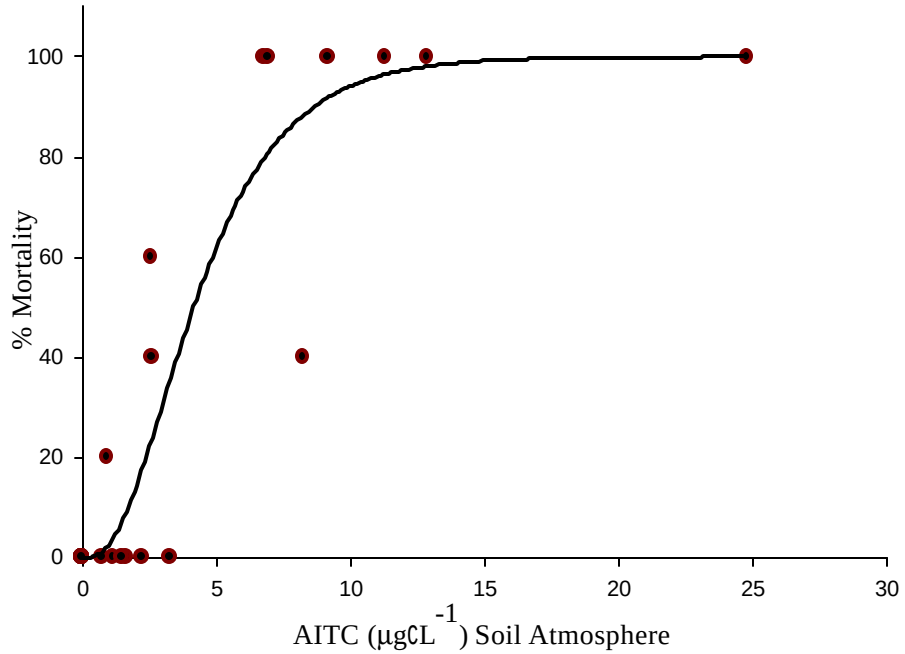

Figure 4: AITC Concentration Versus Larvae Mortalilty (4 h).

Literature Cited

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